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ABSTRACT

This paper shares ideas for creating learning opportunities in mathematics classrooms. Ideas include using single or multiple series of textbooks, markers, teacher-made materials, transparencies and the overhead projector, filmstrips, graphs, songs, money, Geoboards, drill and practice, videotapes, and technology. Mathematics learning activities in the home setting are also discussed. (ASK)

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Challenge and Learning Opportunities in Mathematics

by
Marlow Ediger

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CHALLENGE AND LEARNING OPPORTUNITIES IN MATHEMATICS

To achieve objectives, pupils need to experience learning opportunities. The mathematics teacher needs to choose those activities which will assist pupils to achieve relevant objectives. Thus the chosen leaning opportunities should provide for pupils of different abilities and achievement levels. Pupils do differ from each other in terms of the complexity of mathematics problems they can benefit from. They also differ from each other in terms of interests possessed, motivation, and purpose in studying ongoing lessons and units of study in mathematics. It behooves the mathematics teacher to plan well and thoroughly to guide each pupil to learn as much as possible in mathematics.

Using Single or Multiple Series of Textbooks

Textbooks in mathematics are still popular to use in assisting pupils to achieve relevant objectives. These texts should be chosen carefully so that the best possible learning opportunities are available for pupils. The textbooks need to be clearly written so that learners might understand their contents. Illustrations contained in the textbook should be of value to pupils in clarifying ideas and stimulating interest for learning. Quality sequence needs to be in the offing in that the activities move gradually from the easier to the increasingly complex subject matter. Pupils should experience the sequence that assists continuous achievement. If subject matter in mathematics is too complex, pupils may not learn as much as otherwise would be the case. If it is too easy, boredom and a lack of challenge may set in.

A good accompanying manual provides mathematics teachers with suggestions for objectives, learning opportunities, and evaluation techniques. Pretests for pupils and their results may assist the teacher in determining if a pupil needs to complete work in that unit of instruction or be placed at a different level of achievement. However, the teacher's

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judgment is a better indicator of where a pupil is specifically in an ongoing lesson and unit of study as compared to a pretest or post test contained in the basal textbook. No doubt, a variety of information sources should provide the mathematics teacher data on where the pupil is presently in achievement. From that starting point, the pupil, through learning opportunities, should be assisted in achieving continuous progress.

There are simulated problem areas which do stimulate pupils to learn from a quality mathematics textbook. The text needs to be on the reading level of the involved learner. The pupil can then understand and attach meaning to what is being read. Failure to possess an adequate reading vocabulary will hinder a pupil from doing quality work from using a mathematics textbook. The mathematics teacher needs to assist pupils who have difficulty in reading abstract words contained in the basal textbook.

There is no reason why pupils cannot engage in higher levels of cognition when working story problems from the textbook. Each problem then has a question which is perplexing for the learner to answer. The question requires thought, deliberation, and critical analysis. Hasty answers do not make for problem solving situations. It takes time and effort to solve problems. Pupils need guidance to think through what is wanted in an answer. Learners then gather information to secure the answer. The tentative answer is evaluated to determine its accuracy and feasibility. Reading materials and discussions must be on the understanding level of the individual pupil. Ediger (1988) lists the following criteria of content to be included in a quality basal textbook in mathematics:

1. Proper order or sequence in learning for pupils is in evidence.
2. Adequate illustrations and diagrams are inherent to help pupils understand mathematical concepts, facts, and generalizations.
3. The textbook captures pupil appeal and interest.
4. Key structural ideas are in evidence such as the commutative property of addition and multiplication, the associative property of addition and multiplication, identity elements for addition and multiplication, and the distributive property of multiplication over

addition.

5. The teacher's manual section presents ample suggestions for teaching- learning situations such as objectives or goals, learning activities, and appraisal procedures.

6. The authors are reputable from the point of identifying relevant learnings for pupils to achieve in mathematics.

7. Adequate attention is given to guide pupils to develop proficiency in problem solving and using various algorithms in computation.

8. Opportunities are given for pupils to utilize what has been learned previously.

A carefully selected textbook can be an excellent material of instruction to assist pupils to achieve as well as possible. It is, however, up to the teacher to use the basal textbook in a manner which encourages pupil interest and purpose in learning mathematics. To clarify meanings from textbook instruction, the teacher needs to use concrete, semiconcrete, and abstract materials. Markers of different kinds might then help make clear to pupils what otherwise would be vague.

Using Markers

I believe each primary grade pupil should have a kit of markers to make subject matter understandable. I have noticed when supervising student teachers and regular teachers how many kinds of markers are used in teaching. One teacher had pupils show a set of five and a set of four using corn seeds from their kit. It is relatively easy for a teacher to see which pupils can or cannot do what is asked for. Those who fail to put out the correct number of seeds may need assistance in using one-to- one correspondence in counting the correct number of seeds for each set. The teacher's role here, for example, is to guide pupils to attach meaning to the abstract sentence 5+4= 9. The commutative property of addition was also stressed by the teacher in having a learner put out four seeds and then five seeds for two different sets. The sets were then joined together to show a value of nine.

It is important for the teacher to change off using different kinds of

markers in addition and other operations on number. I have noticed teachers who have pupils use bean seeds, wheat, oats, paper strips, blocks, paper clips, pencils, and crayons, among other markers. Pupils, for example, needed to learn that 4+5 and 5+4= 9 regardless of the kinds of markers used in teaching. Children themselves should be involved to show that 4+5 and 5+4=9.

The mathematics teacher should use different markers or materials of instruction effectively so that each pupil may achieve optimally. One time, I frowned at a teacher using sticks to teach addition in which each pupil kept clicking the sticks loudly. Pupils were playing rather than learning. Disruptions occurred here. I recommended to the teacher, in this case, for her to demonstrate what is to be learned by pupils using the large sticks which all could clearly see in the demonstration. Otherwise, I believe strongly in a hands- on approach in pupil learning.

Teacher Made Materials

I have seen in many classrooms outstanding teaching aids made by classroom teachers which truly assist pupils to achieve objectives. These aids are attractive, well made, and are excellent materials to use as learning opportunities. Flannel boards may be made by teachers and used on any grade level to teach pupils. With the flannel boards, there should be felt cutouts to guide pupil achievement of objectives. I would suggest having cutouts of different colors to attract learner attention in teaching and learning situations. What kind of cutouts might teachers make? These can be felt circles, squares, rectangles, and parallelograms. These cutouts may be used to have primary grade pupils learn geometrical figures. Pupils may also count how many members there are in a set of cutouts. Addition, subtraction, multiplication, and division may be taught used the flannel boards and cutouts. Cardboard, three feet by four feet, covered attractively with flannel can make for an excellent teaching device on which the felt cutouts may be placed. One teacher had the headings from right to left -- ones, tens, hundreds, and thousands on the flannel board.

intermediate grade pupils might then place cutouts to show a value such as 4,567 with four circle cutouts under the thousand's column, five under the hundred's columns, six under the ten's column, and seven under the one's column. Borrowing and renaming can easily be stressed using the place value chart. For example, subtracting 1,328 from 4,567 in the set of counting numbers, one cannot take away 8 from 7, so one ten from the six tens needs to be taken. Thus one 10 and 7 ones equals 17. Now 8 can be taken from 17 leaving 9. Further more, two tens may be taken from the five tens leaving three tens. Three hundreds may be taken from the five hundreds and one thousand may be taken from four thousand leaving 3,239 as the answer.

Most teachers make place value charts from paper by stapling pockets labeled for the thousands, hundreds, tens, and ones columns. Congruent strips of paper are then cutout and placed into each pocket. The strips protrude from each pocket so pupils can readily see how many are under each heading. For example, in the number 3,245, there would be three congruent slips of paper in the thousands column, two in the hundreds column, four in the tens column, and five in the ones column. If 2,134 are to be subtracted from 3,245, the pupil can remove four slips from the ones column, three strips from the tens column, one from the hundreds column, and two from the thousands column (of 3,245), leaving a value of 1,111.

For multiplication, pupils may use the place value chart to show meaning. Thus if pupils are attaching meaning to 3 x 23= 69, three congruent slips of paper may be placed in the ones pocket and two sets of ten each in the tens pocket. Next three sets of three each may be placed placed into the one's pocket and three sets of two tens may be put into the tens pocket. Thus, pupils understand that 3x 3 =9; this numeral would represent how many would be in the ones column. Also, three sets, two tens in each set, would make for six tens in the ten's column. The final product of 3x 23= 69.

Place value charts may well be used to help pupils understand division. If pupils are developing understandings pertaining to the

division problem 42 divided by 2, the dividend of of 42 may be represented by two congruent slips of paper being placed in the one's column and four sets, with ten members in each set rubber banded, being placed in the tens pocket. To divide, the learner may place one member in each of two sets to represent the one's column. Next, the four sets of ten each, rubber banded, may be separated into two equal sets. Thus the answer to the division problem 42 divided by 2 = 21.

Using Transparencies and the Overhead Projector

Overhead projectors may be wisely used in the classroom setting due to the following factors:

1. The teacher faces pupils when using transparencies in a class discussion.
2. Specific content that pupils are to learn only, are placed on the transparency, no more and no less. Irrelevant content then is not a part of ongoing learning activities.
3. Transparencies can be developed which are interesting and appealing to learners.
4. the order of discussing several transparencies may be arranged sequentially from the point of view of the child's own unique perception.
5. Content may be added to a transparency as needed. Content may also be omitted from a transparency.

Transparencies and the overhead projector may be used in the following ways:

1. Pupils count how many members there are are in a set as given in a specific transparency.
2. Learners tell how many members make a new set if two previously given sets are combined or joined together.
3. Pupils tell how many members are left if, for example, there were nine circles and two are taken away.

4. Pupils begin initial learnings in multiplication, e. g., three sets of circles with four members in each set, 3x4=12.

5. The inverse operation of multiplication (division) may be shown and discovered from the previous example, e. g., twelve circles are to be divided equally into three different sets. Thus four members are in each of these three sets.

Using Filmstrips

Filmstrips are excellent devices to use in teaching inductively as well as deductively. The use of filmstrips involves an older device in teaching as compared to modern day videotapes. However, they are excellent to use providing the content is clear and related directly to the objectives of instruction. I have heard teachers and administrators say that filmstrips are outdated to use. I do not believe so. My feelings are that it depends upon the quality of content and how the teacher uses this approach in teaching mathematics. One thing is certain, the frame of the filmstrip remains constant as long as the mathematics teacher wishes to focus on it for meaningful teaching. The teacher can point out items to pupils in a frame and stay on that frame as long as necessary. Content in filmstrips should follow the following guidelines:

1. The content should capture the interests of pupils.

2. Ordered frames must follow a desired sequence so that each pupil may learn as much as possible.

3. Learners should have ample opportunities to learn inductively as well as deductively from sequential frames in a filmstrip. The mathematics teacher may develop questions for a frame which assists and challenges a pupil to respond in a manner stressing learning by discovery.

4. There are good opportunities for the teacher to emphasize a problem from which pupils need to seek answers for a tentative solution involving filmstrip content.

5. A manual should accompany a filmstrip so that teachers may follow the teaching suggestions, if desired.

The following are examples of how filmstrips may be used:

1. To introduce a new unit in mathematics. If pupils are to study addition of unit fractions with unlike denominators, a carefully chosen filmstrip may give learners an overview of the new unit. Pupils can then see how knowledge of unit fractions with unlike denominators is useful in problem solving in class and in life outside the classroom. The unlike denominators need to have a relatively easy greatest common factor so that the numerators may be added and placed over the common denominator.

2. To develop learnings in greater depth. the content of filmstrips guides learners in attaching meaning to fractions such as one-fourth + one-sixth =..., or one third plus one one-sixth =... Social situations stressed in the filmstrip presentation guide learners in perceiving practical application of abstract learnings. In the filmstrip presentation, numerous experiences would be provided pupils in understanding what is involved if unit fractions with unlike denominators are added.

3. To end or culminate a unit of study. In the filmstrip presentation, pupils should have ample opportunities to review what has been learned previously. If pupils can use that which has been learned previously within the framework of purposeful learning experiences, it will be possible to retain these learnings in terms of understandings, skills, and attitudes for a longer period of time than would otherwise be the case.

Content in the filmstrip should provide opportunities for pupils to

1. respond to questions and problems.
2. make practical application of what has been learned previously.
3. arrive at relevant concepts and generalizations at their own unique rate of speed.
4. assess their own achievement in learning.

5. branch out in the direction of new related learnings,

6. experience success and satisfaction in learning.

7. achieve understanding of selected major structural ideas in mathematics such as the commutative and associative properties of addition and multiplication.

8. perceive diverse operations in mathematics as being related such as division undoes multiplication.

The above named eight guidelines may also be stressed in any learning opportunity involving the use of a variety of materials of instruction.

Slides are similar to filmstrips in their use in teaching mathematics. Instead of a frame on a filmstrip, there is a slide to convey information to pupils. Many of my student teachers and cooperating teachers whom I supervise have made slides to use in teaching mathematics. These teachers have placed on each slide what they wish to have pupils learn to achieve objectives. As much time as is needed may be spent discussing and elaborating on mathematics concepts contained in a slide.

Using Graphs in Teaching Mathematics

Pupils need to experience making and using graphs. Graphs developed by pupils with teacher guidance should

1. emphasize content within the experiences of pupils. No pupil should be left out in left field or fall through he cracks in ongoing lessons and units of study.

2. present generalizations in an understandable manner.

3. contain a heading to orientate viewers to inherent content in the graph.

4. provide interesting, meaningful, and purposeful learning activities.

Kinds of graphs to be made by elementary school pupils in

mathematics include

1. picture graphs. Picture graphs may be the easiest to develop and read by pupils. As an example, the birthdays of pupils in a classroom may be placed on a picture graph. Thus pupils whose birthdays are in January should have their pictures placed horizontally next to the name of that month. The same should be done for the rest of the months of the year with pupils' pictures coming horizontally next to the respective month.

2. line graphs. I have seen excellent line graphs made by pupils with teacher guidance on temperature readings for the five days of a school week. Learners may then quickly notice how the line goes up or down to show temperature readings covering a given interval of time. The line may also stay horizontal from one day to the next when reading the thermometer at the same time each day of the week.

3. bar graphs. Information contained in a picture or line graph may also be shown using a bar graph. I have seen several high quality bar graphs in classrooms showing the gross national product in the United States covering the decades from 1940 to the present. The bars became longer as each of these decades passed. The graphs were neatly made and had attractive titles or captions.

4. circle or pie graphs. One very good pie graph I observed showed what part of the circle in a family budget was spent on food, clothing, shelter, insurance, car expense, and miscellaneous. The figures contained in this graph were actual from a specific family. There are a variety of data sources which can be used to develop pie graphs. I viewed a pie graph which contained the land areas of different countries in Europe such as the per cent of land of Germany, England, France, Spain, among others.

It is very relevant that pupils learn to make and read information from graphs. Why? The contents in a graph can be quite misleading if made incorrectly. I recently read information from a line graph contained in a reputable newspaper. The cost of living was shown as rising very,

very rapidly, when actually this was not the case. How was this done? Rectangles rather than squares were used to show the rising cost of living. The rectangles were placed so that the width of these were placed horizontally. The length of each rectangle then was placed vertically, making the cost of living shown in an upward spiraling situation. In a line graph, there should be equal sized intervals, horizontally as well as vertically. This is a fundamental rule in statistics. A person merely looking at a line graph might truly be deceived when looking at unequal sized intervals.

Another graph I read in a newspaper recently showed a pile of coins to indicate donations given by charitable organizations covering ten year intervals from 1950- 1990. The graph did not start from zero but from $50,000. The size of the intervals were $10,000. Since the size of each interval was $10,000 and the beginning value showed $50,000, a value of $100,000 in terms of size of a stack of coins should be twice as high as $50,000. This was not the case. It showed that it was five times more instead. I think we can all understand why pupils at an early age and when ready should achieve relevant goals in statistics. Statistics can certainly be misused!

Using Songs

There are numerous songs that pupils may learn which are enjoyable and yet stress counting using the set of whole numbers. Young children, in particular, benefit form songs involving counting. In learning to sing the song "Ten Little Indians," pupils are learning the correct order or sequence of the set of counting numbers. Later on, pupils need to attach meaning to the set of counting numbers when engaging in rational counting. Here, pupils count objects in one to one correspondence. the learner then touches an object and says "one," counts a second object by pointing to it and saying "two." This sequence in rational counting is continued until achievable goals have been accomplished. Learners need to be ready before stressing rational counting as continuous progress needs to be made.

Using Money

Real coins and play money should be used in teaching-learning situations to guide learners to understand currency values. Real and play money should be used in the following ways:

1. pupils counting members given in a specific set, such as five coins pertaining to the cardinal number of five. Pupils may also develop learnings here pertaining to ordinal numbers, such as a coin is fourth in a specific set. The concepts of first, second, third, fourth, fifth, and so on indicate ordinal value within a set. Thus the ordinal value answers the question of "Which one?'

2. pupils joining two sets together to make a third set. Thus if a pupil spends 25 cents for a candy bar and 20 cents for a package of chewing gum, how much is spent for both items? A set of 25 cents is joined together with a set of 20 cents to make a new set of 45 cents.

3. pupils subtracting where regrouping is involved such as a pupil having 50 cents and spending 22 cents for a candy bar. Here, the teacher needs to help pupils understand that the five tens on 50 cents need to be regrouped in terms of four tens and 10 ones (ten ones come from one ten formerly in the five tens column). Now two ones can be taken from the ten ones leaving eight. Two tens may also be taken from the four tens.

4. multiplying a factor times a factor such as a pupil had 25 cents and needed six times that amount to buy a used baseball glove. thus there are 25 cents in a set; six of these sets are needed to buy the used baseball glove. The factor 25 needs to be multiplied by the factor of 6, making for $1.50.

5. dividing such as where there are 12 doughnuts and these need to be divided so that each of six boys get an equal number. Learners then need to use division to determine that 12 divided by 6 = 2.

Pupils need to use real money to realize that

1. money is used to buy needed goods and services in society.

Pupils may list which goods and services they or their parents have purchased recently. Money use should strongly stress the practical and the utilitarian.

2. application should be made using real money. Too frequently, learners fail to perceive ways of applying that which has been learned. and yet, being able to use what has been learned becomes a major goal of mathematics instruction.

3. meaning in learning is of utmost importance. Pupils should attach understanding to the use of money. Much time is wasted in teaching unless pupils show they understand subject matter taught. Through discussions and questions, pupils reveal what is understood and is meaningful.

Using Geoboards

To assist pupils to understand geometrical forms, the teacher may wish to have pupils use a geoboard. I believe geometry is so vital to a pupil's experiences that the mathematics teacher should devote adequate time in making geometrical instructional aids. Geoboards may be made of plywood. A twenty by twenty square inch piece of plywood should be adequate. Shingle nails, a square inch apart, may be driven in lightly into the square piece of plywood. However, the nails should be stable and sturdy in the plywood.

Rubber bands may be used by pupils, stretched around selected nails, to show diverse geometrical forms such as squares, triangle, rectangles, trapezoids, and other figures.

It may be wise to have pupils develop a mathematics glossary that relates directly to geometrical concepts read about as well as shown on the geoboard. Pertaining to reading for meaning and a mathematics glossary, Ediger (1996) wrote:

Pupils with teacher guidance should have ample opportunities to become independent in attaching meaning to words read. With the use of context clues, the learner may ascertain the identification and

meaning of a word by noticing surrounding words within the sentence. If a pupil, for example, does not know the meaning of the underlined word, the rest of the words in that sentence may take care of the unknown...

I would suggest that teachers assist pupils to develop a mathematics glossary individually or within a committee. This activity indicates that pupils can be authors and be empowered with their very own writing. Arranging words alphabetically is involved here as well as the correct spelling of words. Relevant terms need to appear in the glossary. Definitions of each word must be clear. Examples may clarify meanings of mathematics terms sooner than definitions. It would be good to use each term in a sentence within a contextual situation.

Using Drill and Practice

Pupils need to have opportunities to be drilled on essential basics in mathematics. Generally, addition, subtraction, multiplication, and division facts can cause problems to a few pupils in retaining content. The mathematics teacher always needs to remember that pupils should first understand what a basic addition fact, for example, means. Thus 4+5 = 9 is symbolic and stands for something concrete and semiconcrete. A pupil should then be able to show a set of four marbles and a set of five marbles. The learner should also be able to join the two sets together to show a set of nine members. Pupils should be able to explain what is involved in any basic addition, subtraction, multiplication, and division fact. I recommend strongly that each pupil be able to show comprehension by indicting with concrete and semiconcrete materials the meaning of any operation performed on number pairs such as 4x7=...

A variety of materials need to be used to vary the kinds of learning activities that are involved in drill and practice. Flashcards may be used

to have pupils respond to what, for example, 7x8=... There are excellent computer software packages whereby learners may experience rich experiences in drill and practice. The mathematics teacher needs to capture the interests of pupils in these kinds of experiences. I have seen student teachers and cooperating teachers make excellent teaching aids which stress pupils playing games. These games emphasize drill and practice. Thus these teachers have made a spinner together with a game board, consisting of squares sequentially marked two inches by two inches. If a child hits the value of "five" after using the spinner, he/she may move forward five spaces if a correct response is given to a basic number pair such as 9-5=... This number pair is printed on a card, face down; learners with others playing the game take sequential turns drawing cards. Each player moves forward the number of spaces on the game board as indicated by the point of the spinner. The first pupil that reaches the end of the game board is the winner. Instead of individual pupils playing against each other, a committee may challenge another committe in playing this game.

I have also observed teachers making fish cutouts from different colors of construction paper. On each fish, a number pair is printed. A paper clip is placed into the mouth of each paper fish. A fishing pole or stick with an attached string and a magnet at the end is used to catch fish. If a pupil catches a fish, he/she may keep it providing that a correct response is made as to what is printed on the paper fish such as 3x7=... The fish for fishing should be placed in a paper box or other container whereby the pupil cannot see which number pair is printed on the fish.

Worksheets developed by the teacher, transparencies and the overhead projector, software and the personal computer, as well as pages from workbooks may contain quality drill and practice activities for pupils. Each activity should be goal centered in that pupils remember an answer to a basic number pair better than formerly. I believe that mathematics teachers should always point out to pupils why drill and practice activities are important. These activities are not engaged in for the sake of doing so, but rather that pupils can use and apply what has

been learned. It is always important to remember that pupils should comprehend and attach meaning to whatever is being stressed in the drill and practice activities.

Using Video Tapes

I have observed numerous video tapes that provide excellent learning opportunities for pupils. These videos bring movement and motion into learning opportunities in mathematics. Teachers need to be certain that a video presentation is properly introduced to provide readiness and background experiences for involved learners. Readiness experiences might involve discussing new vocabulary terms with learners as well as presenting needed information that will assist pupils to understand the video presentation in an optimal manner.

The video definitely should be on the understanding levels of pupils, not the frustration nor boredom levels of pupils. The pace of the presentation should harmonize with the sequential comprehension of content of learners. What pupils do not understand, they should receive clarification of these ideas, concepts, and generalizations from the teacher. Monitoring of pupils before, during, and after the video is important. Time on task needs to be emphasized by the teacher. Learners should be guided to become responsible individuals and assume self direction roles in mathematics achievement. Most videos tend to secure pupil interest. The teacher also needs to be certain that there is pupil perceived purpose in observing the contents in the video. Thus the mathematics teacher may give a few reasons as to why the contents in the video are important to comprehend.

Video presentations may pertain to

1. one or more problems in mathematics that pupils individually or in committees need to solve. Assistance needs to be provided pupils in securing the necessary information for the identified problem areas.

2. practice and drill that pupils need in order to work more proficiently in addition, subtraction, multiplication, and division. Drill

and practice activities may truly stimulate learner achievement when using videos.

3. games that pupils may play individually or collaboratively. I have observed much interest in pupils being actively involved in videos that stress the playing of games. Positive attitudes toward mathematics may well be an end result here.

4. history of mathematics. A video that instills much interest in pupil learning pertains to information on the history of measurement such as how the foot, yard, and inch was initially determined. I have observed much pupil excitement in these kinds of learning opportunities involving videos.

5. geometry in the mathematics curriculum. Here, learners are assisted in determining areas, as well as perimeters of squares, rectangles, circles, and trapezoids. Recently, I observed a film that presented outstanding content stressing finding areas and perimeters of selected figures. There are educators who will say that films are outdated in the mathematics curriculum. That would depend more upon the content presented rather than is it a film that is used as a teaching material.

Using Technology

Advocates of using modern technology believe schools should move in the direction rapidly of being very updated in the use of technology. Why? Society uses computers, modems, internet, worldwide webs, and modern search engines to locate needed information. Unless schools use the state of the art technology, they and their pupils will be left further and further behind in developing skills needed in the twenty-first century. Learners need to be productive individuals now as well as in the future in the use of technology. The technological skills developed will update a pupil for his/her future roles as a productive member in society. Pupils need to use knowledge and skills which assist in being contributors to an improved society. Today's

pupils should not lose out on the modern and the futuristic in the school setting. Losing out now will hinder pupils in developed harmoniously well with what is and exists in society and what will be in the future.

The are others who believe that too much money can be spent in having a school possess state of the art technology. Repair and maintenance costs are heavy in keeping modern technology moving forward. Technology, it is stated by selected educators, can not meet the needs of pupils as can good teachers who creatively devise materials of instruction which guide optimal progress for individual pupils.

Kinds of software. Mathematics teachers need to select software carefully for computer use. Computers should not be used for the sake of doing so, but rather to assist learners to attain more optimally in mathematics. Computer use should stress what other kinds of materials cannot accomplish when used in teaching and learning. Thus, computer programs should assist pupil to learn that which, for example, a textbook or a workbook cannot provide.

Computer programs should guide pupils to attain relevant objectives in mathematics. Programs used should assist pupils to make continuous progress and to attain optimal achievement. I will review different kinds of software programs available to guide pupils to achieve as much as possible in mathematics. A first kind of software program emphasizes relevant subject matter such as sequential facts, concepts, and generalizations that pupils need to learn. These learnings are presented in a sequence which moves in ascending order of complexity. Vital knowledge in mathematics needs to be in the offing here. For example, if pupils are to learn to divide using a two place divisor with a remainder in the quotient, the inherent facts, concepts, and generalizations need to be presented in program form. The software program moves forward to increasingly levels of complexity. Thus a pupil looks at content expressed in one or two sentences containing numerals and/or operation signs in most cases. He/she then responds to a test item covering what was read and studied in the one or two

sentences. If the learner responded correctly, he/ she is rewarded and may go on tow the next pair of sentences to be read. A pupil that responded incorrectly may try again in making a response that is correct. If it is incorrect again, the correct answer is given and the learner may go on to the next sequential content to read and respond to. Being correct in responding the first time is the reward; operant conditioning is in evident here. Operant conditioning stresses rewarding the correct response made so that the learner is conditioned to respond correctly each time the situation requires the same answer. Facts, concepts, and generalizations in mathematics require specific content to be learned. The content is exacting and specific. Facts pertain to such items as answers to the basic addition, subtraction, multiplication, and division number pairs, i.e. 6+5=..., 4+3=..., 2+3=..., among others. Concepts emphasize single words or phrases such as addition, subtraction, multiplication, division, square root, cube root, dividend, quotient, divisor, factor, and diameter, among others. Generalizations are usually stated orally or in writing within complete sentences using subjects and predicates in each. The following are examples of generalizations:

1. The associative property of addition states that we can add numerals in any order and the sum is the same.
2. To find the circumference of a circle, we need to know the diameter and multiple it times pi (3.14 approximately).
3. To determine the area of a right triangle, we need to multiply the base times the height and then divide by two.

Each generalization needs to be clear and meaningful. Thus in number two above, pupils should attach meaning to the concepts of circumference, diameter, and pi, prior to working on securing the circumference of circle. Seeing circles in circular windows, drawings and models, as well as in illustrations should aid learners to attach meaning to the concept of "circle." Teacher explanation of the concept of diameter using actual circles in the semiconcrete or in the concrete

assists learners to attach meaning and understanding to the term "diameter." Emphasizing meaning theory in teaching mathematics is vital and salient.

A second type of software material available in teaching mathematics stresses pupils reviewing that which has been learned previously so that forgetting is minimized. I would suggest here that the software program emphasize interest in learning on the part of learners. Too frequently, reviewing what has been learned previously is boring. Must it be that way? The answer is "definitely no." I have noticed software and teacher made materials in mathematics which are highly interesting to pupils. Using flash cards containing basic number pairs for review and drill is only one method of assisting pupils to rehearse that which has been learned previously. These number pairs such as 5+3= ... might then be shown on a card clearly visible to the learner receiving the review opportunities. Smudge marks and other visible marks should be erased or new cards made so that learners identify what the answer to the basic number pair is, 5+3= ... in this case, and not by the smudge marks that are on a card. I have observed pupils who state that they recognize the answer to a basic number pair by the smudge marks rather than by the numerals provided on a three by five inch card. Pupils may also work in dyads with the two involved learners drilling each other on what has been learned.

An amusing incident occurred when a pupil in using an electrically wired answer board stated he did not know many of the basic multiplication number pairs presented but he could find out quickly by looking on the back of the board to see how it is wired. Thus in responding to 9x8=..., the pupil did not know the answer but could determine the answer by looking on the back to see what the answer would be by noticing the connections of the electrical wiring used. In this electric board, a light would go on if the pupil took the two wires to match up 9x8=72. The 9x8=... was in one column and the 72 in the second column, in random order with the answers to basic multiplication number pairs previously studied in class. The mathematics teacher then

needs to be sure that pupils respond to the numerals in the multiplication facts rather than how the electric board is wired. One great advantage in using software and the computer to stress drill and practice is that pupils cannot identify answers through smudge marks on the monitor or see how the computer is assembled to determine which answer is correct.

A third type of software program emphasizes using problem solving. Here, pupils may simulate real live situations in a virtual reality situation. Each problem stress higher levels of cognition involving critical and creative thinking within the framework of problem solving. Each problem should be challenging to pupils. Thus there is a perplexing situation in which the learner needs to ascertain what the problem is which needs solving. Critical thinking is involved when the learner analyzes that which is needed to solve the problem. Thus the relevant needs to be separated form the irrelevant. A problem may have many steps involved in working toward a solution. Creativity is inherent when the pupil determines which algorithm to use as well as which sequence to stress in problem solving. In short, the pupil needs to perceive the problem clearly with meaning involved. He/she needs to develop an hypothesis in answer to the problem. The hypothesis is tentative and needs testing or trying out to see if it truly works. Thus an hypothesis is always tentative, not an absolute. If testing the hypothesis reveals that it did not solve the problem, then a revision of the hypothesis needs to be forthcoming.

Simulated software stresses pupils engaging in problem solving activities. Reality is emphasized as much as possible in simulation. The content herein is different as compared to computer emphasis upon learners acquiring new content outside problem solving. Simulation also differs from drill and practice activities in that the latter advocates pupils practicing what has been learned previously so that it will not be forgotten.

A third approach in computer software use is to stress a game approach. I have observed on numerous occasions how fascinated and interested mathematics can become in a gaming approach. Pupils may

work individually or in a committee when computerized games are used in teaching and learning situations. Games can be a regular inherent part of the mathematics curriculum or be stressed during free time or during recess time.

A pupil when competing against the self can observe how well he/ she can do in a recreational approach in learning mathematics. If a learner competes against another pupil, he/she must learn to respect others and not stress a dog eat dog approach in mathematics. If committees compete against each other in a game, wholesome attitudes need to be developed. The goals are to acquire new subject matter as well as achieve wholesome attitudes toward mathematics and toward others. The use of games can be an excellent way for pupils to learn vital mathematics content. If the home setting has a personal computer, the mathematics teacher should assist parents in securing software games which will challenge and nurture the learner. The home and school should work together for the good of the pupil. To frequently, the goals of the home and school are so opposite to each other that learner optimal achievement is not possible.

Learning Activities in Mathematics in the Home Setting

Through parent/ teacher conferences, the goals of the home and of the school might be harmonized. The mathematics teacher needs to have positive suggestions to parents as to how they can help the learner do well in mathematics. I would suggest the following as guidelines for a parent/ teacher conference:

1. respect the thinking of parents in the face to face situation.
2. find out how the child feels toward mathematics.
3. diagnose what the child needs in mathematics; the home setting might be able to assist the child to overcome these deficiencies.
4. guide parents to encourage the pupil to learn and to achieve.
5. suggest to parents learning activities which will guide the pupil to achieve in mathematics in the home setting.
6. listen carefully to the concerns of parents.

7. have parents consider the physiological as well as the social dimensions of the pupil's development, if there are indications that this needs to be done. A tired and hungry child can not do well in school. The school also should do as much as possible to meet nutrition, clothing, emotional, social, and other needs of the learner. If these needs are met of pupils, learners should then attain more optimally in mathematics.

8. guide parents in being able to reward the learner for doing well in mathematics.

9. assist parents in discussing what the offspring has learned in mathematics for a given school day. Parents should show much interest in the child's welfare.

10. have the child involved in discussing everyday problems in mathematics, such as how much a given set of items purchased in a supermarket cost.

Kennedy and Tipps (1991) wrote:

Teachers have another resource for helping children. Teachers can involve parents to help children learn mathematics. Teachers have a variety of ways in which to include parents or guardians in the program. Some write weekly or monthly newsletters that communicate the topics being studied and make suggestions for home activities. Some textbooks now include model newsletters in their teaching manuals. Other teachers ask parents to volunteer in the classroom. Parent volunteers need tasks organized for them such as reading books or working with a mathematics game. Some teachers have have created take home versions of mathematics materials. Students check out the games, manipulatives, or investigations to use with parents at home. Homework can also be designed to include home projects. A geometry scavenger hunt and a survey of favorite foods are good ways to involve parents and siblings...

In Closing

A variety of learning activities need to be in the offing for pupils so that each may achieve as much as possible. The learning activities need to assist pupils to achieve stated, relevant objectives. Each activity should provide for individual differences. Thus a learner is guided to attain more optimally. Each pupil should learn as much as possible in

mathematics. To vary learning activities makes it possible for each pupil to achieve more optimally in mathematics. Learners need to achieve knowledge objectives with its vital facts, concepts, and generalizations. They also should attain relevant skills objectives which include creative and critical thinking as well as problem solving. These skills are vital for pupils to achieve and cannot be left to chance. Rather the mathematics teacher plans relevant skills within lessons and units of study so that each pupil might attain these higher cognitive level objectives. The teacher then has definite learning opportunities that focus upon pupils achieving problem solving skills as well as becoming proficient in creative and critical thinking. Pertaining to problem solving, Ediger (1996) wrote the following:

Learners need to have ample opportunities to engage in solving realistic problems. Situations in life demand that human beings become proficient in problem solving Thus, pupils should have ample opportunities to engage in the solving of real problems. Pupils with adequate background information could solve problems such as the following:

1. a miniature supermarket could be housed in the class setting. Learners may bring empty cereal boxes, fruit and vegetable containers, candy bar wrappers, flour sacks, and sugar bags. These items should be placed on a counter, properly labeled and priced. Pupils may "buy" needed items using toy money. Thus, needed addition, subtraction, multiplication, and division facts may be learned in this manner.
2. A "cafeteria" could also be set up in the class setting. Cutouts of appropriate food items may be pasted on paper plates. Each food item would need to be priced meaningfully. Learners again may use toy money to purchase selected food items in the "cafeteria."
3. The mathematics laboratory concept of teaching and learning can well become an important facet of the mathematics curriculum. Thus, pupils may measure areas, distances, and determine volumes of specific containers in actual problem solving situations utilizing the English as well as the metric systems of measurement.
4. Realistic problems may also be solved by pupils within the framework of the use of reputable textbooks films, filmstrips, slides, video-tapes, and life-like situations in society.

A third type of objective for pupils to achieve are attitudinal goals. If pupils attain important attitudinal objectives, they should do better in realizing knowledge and skills objectives. Attitudinal objectives include

pupils appreciating, valuing, being interested in, and perceiving purpose in studying mathematics. To achieve any vital objective, the mathematics teacher needs to select and adapt specific learning opportunities to the present achievement level of the individual learner. Pupils should also learn to work together well with others in ongoing lessons and units of study. Being able to work effectively with other learners is significant. Later, in adult life at the work place, it becomes exceedingly important that the pupil be able to work well with others. At the present time in school, pupils need to tolerate, understand, and value each other.

To assist pupils to achieve optimally in mathematics, the teacher needs to be able to work harmoniously with parents of children in the classroom. Parent/teacher conferences are important to harmonize the efforts of the teacher and school with that of the involved parent. There are many ways in which parents can help in having their offspring achieve as much as possible in mathematics. Parent/ teacher conferences should stress good human relations as well as look at what a child needs in mathematics to do as well as possible. Cooperatively, the parent and the teacher can work out a plan for the pupil to achieve well in mathematics. There are advocates of having pupils being involved in the parent/teacher conference. This has much to offer if arrangements can be made for this to occur. The pupil might then evaluate the self in terms of what is needed to be more successful in mathematics. The pupil may tell about his/her work in mathematics in terms of products completed. Within this endeavor, the learner may reveal personal talents, interests, and attitudes toward mathematics. Journal writing can be very personal in which the learner records on a daily basis what has been learned and what is left to achieve. The pupil in a parent/teacher conference may wish to share his/her written journal entries to indicate achievement and diagnosis. Good human relations and working together for the good of the child in mathematics are ultimate objectives in parent/teacher conferences.

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